

I claim:

1. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells comprising:
  - a. means for a tractor connection;
  - b. means for adjusting planted seedling spacing;
  - c. means for seedling tray size adjustment;
  - d. means for seedling tray spacing adjustment;
  - e. means for individual seedling extraction; and
  - f. means for seedling positioning and planting such that the seedling is positioned at the planting means and the seedling roots surrounded with soil.
2. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 1 further comprising the means for a tractor connection is comprised of:
  - a. a multitude of hitch attachment devices, and a connection to the tractor hydraulic system;
  - b. the tractor hydraulic system connection including a quick disconnect piping fitting and a valve.
3. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 2 further comprising the means for adjusting planted seedling spacing is comprised of:
  - a. a control camshaft having a hydraulic motor, a cam shaft, a multiplicity of cams, a multiplicity of cam followers, and a multiplicity of cam follower switches, the hydraulic motor removably connected to the tractor hydraulic system such that the motor turns at a speed proportional to the speed of the tractor, the cams adjustably connected to the camshaft and the camshaft connected to the motor such that the cams rotate at the speed of the motor, the speed of the motor determined by the hydraulic pressure from the tractor which varies proportionate to tractor speed and the position of the valve in the piping connected to the motor; the cam followers moving linearly in response to the cam rotations such that they activate the follower switches at each rotation of the camshaft wherein the seedling tray spacing adjustment means, the seedling extractor means, the seedling tray positioning and advancing means and the

seedling positioning and planting means are controlled at relative times set by the relative angular locations of the cams on the camshaft wherein the spacing of the seedlings in the ground may be varied by varying the hydraulic pressure to the camshaft motor to vary the speed of the camshaft.

4. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 3 further comprising the seedling tray size adjustment means is comprised of:
  - a. a tray holder adjustment bar;
  - b. a tray inlet support;
  - c. a tray intermediate support with a tray contact surface;
  - d. a lower tray support;
  - e. a left adjustable tray guide;
  - f. a right adjustable tray guide;
  - g. a multiplicity of tray hold-down strips;
  - h. the inlet support attached to the intermediate support such that the two supports provide a transition space for inserting the seedling tray edges into the tray guides with the surface of the tray supported at the hold-down strip locations and the tray bottom touching the intermediate support contact surface and the tray lower support; and
  - i. the tray holder adjustment bar arranged to adjustably support the tray guides.
5. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 4 further comprising the means for adjusting planted seedling spacing is comprised of a first extractor means and a second extractor means per tray holder, the cams, cam followers and cam follower switches arranged such that at each camshaft rotation the seedling positioning and planting means is controlled a first time and a second time and the first extractor means is controlled to position a seedling at the planting means with the first seedling positioning and planting means time, and the second extractor means is controlled to position a seedling at the planting means with the second seedling positioning and planting means time whereby the seedlings are positioned at staggered spacing.

6. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 4 further comprising the seedling tray spacing adjustment means is comprised of:
- a. a frame with an upper tray holder roller attachment edge and a lower tray holder roller attachment edge;
  - b. a seedling tray holder with a tray holder adjustment bar, a tray intermediate support with a tray contact surface and a roller attachment surface, and a seedling tray advance mechanism;
  - c. the seedling tray holder intermediate support with two grooved support rollers mounted on the roller attachment surface such that the grooves of the support rollers fit between the frame upper and lower roller attachment edges wherein the edges movably support the tray holder such that the tray holder may move in two lateral directions;
  - d. the tray holder adjustment bar arranged to connect a tray holder to the adjacent tray holder adjustment bar;
  - e. a seedling tray advance cage with a multiplicity of advance bars;
  - f. a seedling tray advance cage operating shaft arranged to connect a multiplicity of advance cages;
  - g. a seedling tray advance cage rotation assembly arranged on one advance cage, the assembly having a drive cylinder assembly and an advance cage rotation assembly connectedly arranged on an advance mechanism frame such that motion of the drive cylinder assembly causes the cage rotation assembly to engage an advance cage advance bar wherein the bar motion rotates the advance cage operating shaft, the advance mechanism advance cage operating shaft and advance cage bars arranged such that the axis is parallel to the tray intermediate support contact surface, and further arranged such that one bar of the advance cage projecting above the plane of the surface of the tray intermediate support wherein a seedling tray inserted in the seedling tray holder will be supported along a row of seedling cells by the protruding bar, and the tray holder lower support located below the protruding bar such that rotation of the advance cage operating shaft by a cycle of motion of the drive cylinder assembly moving the cage rotation assembly will rotate the advance bar such that the

projecting bar moves below the plane of the surface of the tray intermediate support as the next bar of the cage forcibly touches the seedling cell such that the tray is moved down as the next bar moves into a position to project above the plane of the surface of the tray intermediate support wherein the seedling tray is supported by the bar at the next higher row of cells;

- h. a seedling tray size adjustable control system with a double acting drive cylinder, a drive cylinder stroke length adjustment, a hydraulic fluid reservoir, a hydraulic double rod end hydraulic piston pump, a double rod end seedling tray positioner, a seedling tray positioner stroke limit switch, two manual control valves, a diverter valve, a diverter reset control cylinder, a hydraulic directional control valve a directional control valve control cylinder and a control logic;
- i. the seedling tray size adjustable control system drive cylinder reciprocating motion controlled by a seedling planting apparatus control camshaft follower switches, the length of the motion adjustably limited by adjustable stops on the stroke length adjustment, the hydraulic piston pump moving with the drive cylinder and hydraulically connected to the hydraulic fluid reservoir and seedling tray positioner such that a substantially repeatable volume of hydraulic fluid is delivered to the seedling tray positioner at each stroke of the drive cylinder wherein the seedling tray positioner is moved the distance between one seedling tray cell at each cycle such that one seeding at a time in succession may be extracted from the tray; and
- j. the seedling tray size adjustable control system diverter and the directional control switch hydraulically connected between the hydraulic piston pump and the seedling tray positioner, the seedling tray positioner stroke limit switch adjustably set such that the end of the seedling tray cells activates the switch such that switch activation activates the control logic such that the seedling tray advance drive cylinder is activated wherein the tray is advanced one row of cells, the directional control switch is activated such that the direction of motion of the seedling tray positioner is reversed and the diverter reset control cylinder is activated such that the diverter reset stops motion of the seedling tray positioner for one stroke of the drive cylinder wherein the seedling tray is moved one row and is in position for extraction of the first seedling cell in the row, wherein the seedling tray positioner is moved the distance between one

seedling tray cell at each cycle such that one seedling at a time in succession may be extracted from the tray.

7. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 6 further comprising the individual seedling extraction means is comprised of:
  - a. a multitude of seedling extractors configured at each tray holder, each with a housing, an extension tube with an operating end and an insertion end, the insertion end slidably installed in the housing, an inside wall and an outside wall, a top side and a bottom side, the bottom side containing a longitudinal slot with a slot entrance and a slot end, a retaining pin hole, a control rod, a control rod end arranged to , an extractor seedling handler slidably installed in the extension tube operating end with a seedling end and a u-shaped spring end, the seedling end with a first blade and an opposing second blade, each opposing blade having an end, a seedling grasping portion, a sloped portion, a u-shaped spring end, the u-shaped spring end springedly connected in a u-shape, an extractor handler retaining pin, a drive mechanism, the drive mechanism controlled by the control camshaft, and a release mechanism;
  - b. the extractor seedling handler blade sloped portion arranged for two normal positions, a closed position where the blade is slidably within the extension tube inside wall the sloped portion springedly pressing against the inside wall such that the opposing blade seedling grasping portions are positioned such that the ends converge and substantially touch, and an open position where the blade is arranged with the sloped portion outside the extension tube, the sloped portions apart such that the opposing blade seedling grasping portions move apart wherein the ends diverge, the retaining pin arranged such that the spring end sliding motion within the extension tube is limited wherein the blade is retained within the extension tube in the open position;
  - c. the seedling extractor drive mechanism with a drive cylinder and piston, a drive track with a slot and two drive connectors, the first drive connector on the housing and the second on the extension tube arranged to move the seedling extractor extension tube relative to the housing with motion of the drive mechanism and arranged such that a follower pin on the extension tube drive connector is confined within the slot in the drive track such that the motion of the seedling extractor extension tube follows the

shape of the slot in the drive track wherein as the drive mechanism moves to extend the portion of the extension tube out of the housing, the motion slopes the extension tube up to the horizontal position and further drive mechanism motion moves it linearly such that the seedling extractor blade ends in the open position may enter a seedling cell of a tray in the tray holder, and the continued extension tube linear motion causes the control rod end to contact the blade u-shaped spring end and slidably move the blade inside the extension tube such that the spring force of the blade sloped portion on the extension tube inside wall moves the opposing blade seedling grasping portions to the closed position such that the seedling ball is confined within the blade seedling grasping portions, and wherein as the drive piston moves it retracts the extension tube and the seedling ball is removed from the tray cell and wherein as the drive piston moves it retracts the extension tube, the linear motion removes the extractor blade ends from a seedling cell and the seedling ball is removed from the tray cell until the drive completes the linear motions portion and further motion slopes the extension tube in the downward direction; and

- d. the seedling extractor release mechanism having a release bushing, a spring guide rod and a release spring arranged such that as the drive mechanism moves the extension tube towards the lower end of the track slot the release bushing compresses the release spring and the spring force causes the bushing to contact the extractor blade spring end, the resulting force of the bushing on the blade slidably extending the blade in the extension tube towards the open position until the blade spring end contacts the retaining pin, such that the opposing blade seedling grasping portions are in the open position, and as the drive mechanism moves the extension tube towards the lower end of the track slot, the seedling extractor control rod end moves past the extension tube slot end to contact the seedling such that the seedling is removed from the extractor blade seedling grasping portions.
8. An adjustable tray size seedling planting apparatus for a multitude of seedlings contained in a tray configured with multiple rows of seedling growing cells as in claim 7 further comprising the seedling positioning and planting means is comprised of:
    - a. a multitude of seedling chutes, the seedling chutes configured at each seedling extractor, each having an inside surface and an outside surface, a receiving end and a

kicker end the inside surface of the kicker configured to reduce the cross-sectional area with distance from the receiving end, the receiving end arranged such that the extractor positioned at the lower end of the extractor track slot to release a seedling causes the seedling to drop into the chute inside surface, the kicker end with a kicker slot with an upper end and an open end, a movable kicker with a blade, an operating lever arranged to move the blade, an operating shaft, and a drive cylinder, the drive cylinder arranged to rotatably move the drive shaft, such that it moves the operating shaft and swingably moves the kicker blade, then rotatably move the drive shaft in the opposite direction such that the kicker blade is substantially returned to the original position, the blade with a horizontal portion and a vertical portion, the horizontal portion configured to fit within the chute cross-section at the upper end of the kicker slot and arranged such that a seedling dropping in the chute will be retained by the kicker horizontal portion, the vertical portion configured substantially in the side configuration of a seedling tray cell wherein swing motion of the kicker blade out of the slot moves the horizontal portion to an angle and drops a retained seedling from the chute and swing motion in the opposite direction brings the vertical portion in contact with the dropped seedling to place it in the vertical position; and

- b. a multitude of seedling planting mechanisms, each seedling planting mechanism configured at each seedling chute, each comprising a furrow shaper shoe with a left blade with an inside surface and an outside surface, a right blade with an inside surface and an outside surface, and a connecting tip, and furrow closure means, the furrow shaper shoe configured such that the tip is toward the direction of travel of the planting apparatus, the blade outside surfaces configured to create a furrow essentially in the shape of a seedling tray cell, the blades having a gap between the inside surface configured in the shape of a seedling tray cell and arranged below the seedling chute kicker end wherein a seedling dropped from the chute will fall in the gap and the vertical portion of the kicker will align the seedling between the inside surfaces of the planting mechanism, the furrow closure means then closing the furrow around the seedling.
9. A method of transplanting seedlings from tray containers of differing sizes and seedling spacing to a prepared growing field comprising:

- a. connecting an adjustable tray size seedling planting apparatus to a tractor;
  - b. adjusting the seedling planting apparatus for the tray container size;
  - c. inserting seedling tray containers in the seedling planting apparatus;
  - d. setting the seedling planting apparatus to the tray container seedling spacing; and
  - e. moving the tractor connected to the planting apparatus continuously along the furrows in a growing field.
10. A seedling extractor apparatus for removing seedling root balls from a seedling tray configured with multiple rows of seedling growing cells and arranged on a vertical holder such that the seedling cells are horizontal comprising:
- a. a housing, an extension tube with an operating end and an insertion end, the insertion end slidably installed in the housing, an inside wall and an outside wall, a top side and a bottom side, the bottom side containing a longitudinal slot with a slot entrance and a slot end, and a retaining pin hole, a control rod, a control rod end, an extractor seedling handler slidably installed in the extension tube operating end with a seedling end and a u-shaped spring end, the seedling end with a first blade and an opposing second blade, each opposing blade having an end, a seedling grasping portion, a sloped portion, a u-shaped spring end, the u-shaped spring end springedly connected in a u-shape, an extractor handler retaining pin, a drive mechanism, the drive mechanism controlled by the seedling control camshaft, and a release mechanism;
  - b. the extractor seedling handler blade sloped portion arranged for two normal positions, a closed position where the blade is slidably within the extension tube inside wall the sloped portion springedly pressing against the inside wall such that the opposing blade seedling grasping portions are positioned such that the ends converge and substantially touch, and an open position where the blade is arranged with the sloped portion outside the extension tube, the sloped portions apart such that the opposing blade seedling grasping portions move apart wherein the ends diverge, the retaining pin arranged such that the spring end sliding motion within the extension tube is limited wherein the blade is retained within the extension tube in the open position;
  - c. the seedling extractor drive mechanism with a drive cylinder and piston, a drive track with a slot arranged with a linear portion and a sloping portion, and two drive connectors, the first drive connector on the housing and the second on the extension



tube arranged to move the seedling extractor extension tube relative to the housing with motion of the drive mechanism and arranged such that a follower pin on the extension tube drive connector is confined within the slot in the drive track such that the motion of the seedling extractor extension tube follows the shape of the slot in the drive track wherein as the drive mechanism moves to extend the portion of the extension tube out of the housing, the motion moves the extension tube in a slope up to a horizontal position and further drive mechanism motion moves it on the linear portion such that the seedling extractor blade ends in the open position may enter a seedling cell of a tray in the tray holder, and the continued extension tube linear motion causes the control rod end to contact the blade u-shaped spring end and slidably move the blade inside the extension tube such that the spring force of the blade sloped portion on the extension tube inside wall moves the opposing blade seedling grasping portions to the closed position such that the seedling ball is confined within the blade seedling grasping portions, wherein as the drive piston moves in the opposite direction, it retracts the extension tube and the linear motion removes the extraction blade ends from the seedling cell, and the seedling ball is removed from the tray cell until the drive mechanism linear motion completes the linear motion portion and further motion slopes the extension tube in the downward direction; and

- d. the seedling extractor release mechanism having a release bushing, a spring guide rod and a release spring arranged such that as the drive mechanism moves the extension tube towards the lower end of the track slot the release bushing compresses the release spring and the spring force causes the bushing to contact the extractor blade spring end, the resulting force of the bushing on the blade slidably extending the blade in the extension tube towards the open position until the blade spring end contacts the retaining pin, such that the opposing blade seedling grasping portions are in the open position, and as the drive mechanism moves the extension tube towards the lower end of the track slot, the seedling extractor control rod end moves past the extension tube slot end to contact the seedling such that the seedling is removed from the extractor blade seedling grasping portions.
11. A seedling extractor apparatus for removing seedlings from a seedling tray configured with multiple rows of seedling growing cells and arranged on a vertical holder such that

the seedling cells are horizontal as in claim 10 further comprising a tall seedling bender bar located above the extractor and arranged such that seedlings sufficiently tall to impede extractor operation are bent in the upward direction by the bender bar wherein the extractor blades have unimpeded access to the seedling ball.

12. An apparatus for positioning seedling trays configured with multiple rows of seedling containing growing cells on a seedling planter, each positioning apparatus comprising:
  - a. a frame with an upper tray holder roller attachment edge and a lower tray holder roller attachment edge;
  - b. a seedling tray holder with a tray holder adjustment bar, a tray intermediate support with a tray contact surface and a roller attachment surface, and a seedling tray advance mechanism;
  - c. the seedling tray holder intermediate support with two grooved support rollers mounted on the roller attachment surface such that the grooves of the support rollers fit between the frame upper and lower roller attachment edges wherein the edges movably support the tray holder such that the tray holder may move in two lateral directions;
  - d. the tray holder adjustment bar arranged to connect a tray holder to the adjacent tray holder adjustment bar;
  - e. a seedling tray advance mechanism with an advance cage with a multiplicity of advance bars;
  - f. a seedling tray advance cage operating shaft arranged to connect a multiplicity of advance cages;
  - g. a seedling tray advance cage rotation assembly, the assembly having a drive cylinder and an advance cage rotation assembly connectedly arranged on the advance mechanism frame such that motion of the drive cylinder assembly causes the cage rotation assembly to engage an advance cage advance bar wherein the bar motion rotates the advance cage operating shaft, the advance mechanism advance cage operating shaft and advance cage bars arranged such that the axis is parallel to the tray intermediate support contact surface, and further arranged such that one bar of the advance cage projecting above the plane of the surface of the tray intermediate support wherein a seedling tray inserted in the seedling tray holder will be supported along a

row of seedling cells by the protruding bar, and the tray holder lower support located below the protruding bar such that rotation of the advance cage operating shaft by a cycle of motion of the drive cylinder assembly moving the cage rotation assembly will rotate the advance bar such that the projecting bar moves below the plane of the surface of the tray intermediate support as the next bar of the cage forcibly touches the seedling cell such that the tray is moved down as the next bar moves into a position to project above the plane of the surface of the tray intermediate support wherein the seedling tray is supported by the bar at the next higher row of cells; and

- h. a seedling tray size adjustable control system with means for moving the seedling tray positioning apparatus the distance of one cell along a row of cells such that the tray seedling cells move to a reference point in succession wherein one seedling at a time may be extracted from the tray, and means for reversing the direction of motion of the seedling tray positioning apparatus when the last seedling in a tray row is extracted, and means for activating the seedling tray advance mechanism to move the tray next row to the reference point and such that when the seedling tray is moved to the next row the positioning apparatus moves the tray seedling cells in that next row to a reference point and the seedlings may be extracted.